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(54) **Flexible multi-layered wiring board**

(57) A flexible multi-layered wiring board includes a first glass epoxy base 1, at least one second glass epoxy base 2, 3, and a glass epoxy resin layer 4, 5. The first glass epoxy base 1 has a thickness enough to impart flexibility and circuit patterns 11a, 11b formed on two surfaces thereof. The second glass epoxy base 4, 5 has circuit patterns 12a, 12b, 13a, 13b formed on two surfaces thereof and is stacked on the first glass epoxy base 1 in a thick region. The glass epoxy resin layer 4, 5 is arranged between the first and second glass epoxy bases to insulate the circuit patterns and adhere the first and second glass epoxy bases.

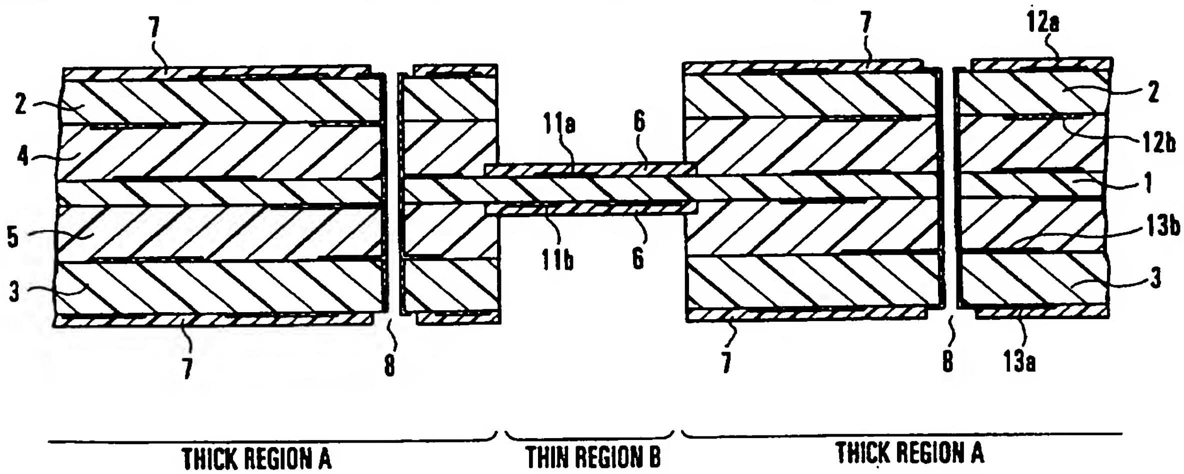

FIG.1

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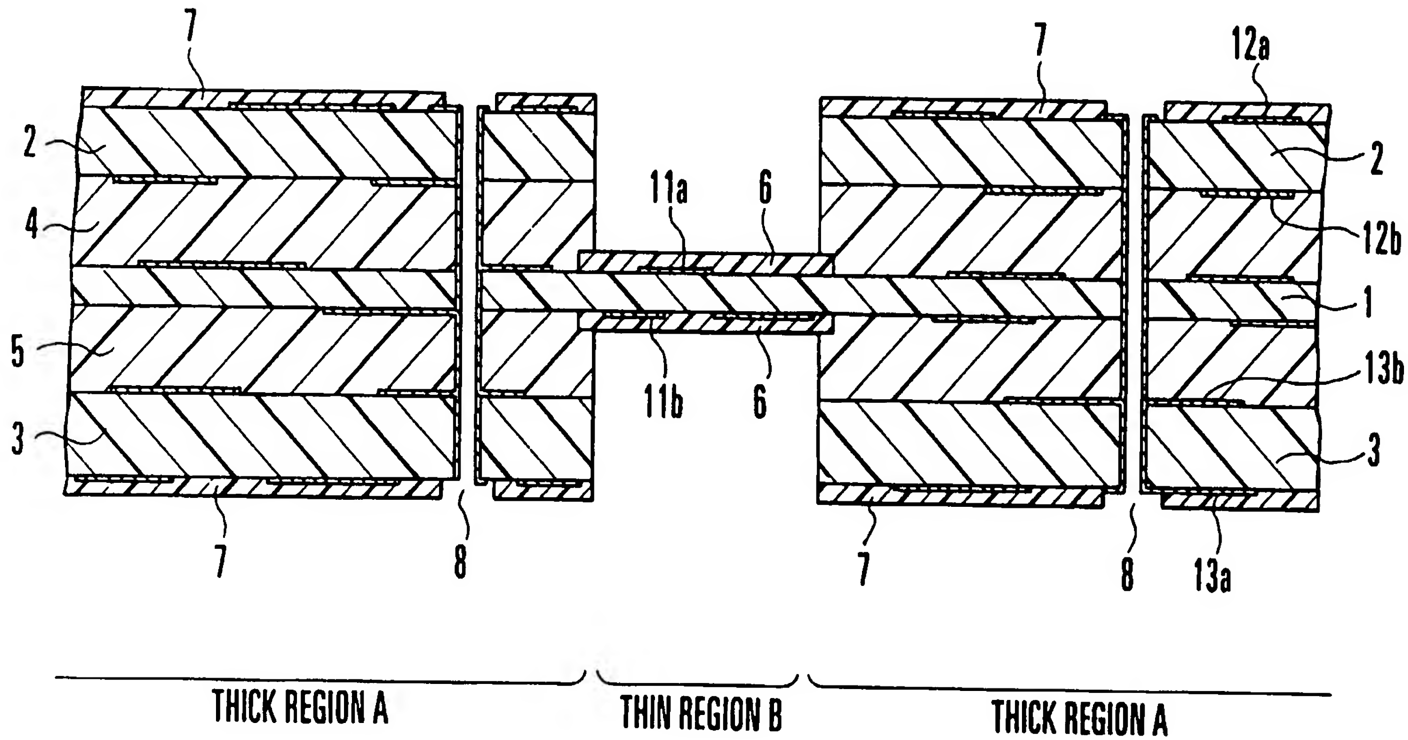
7
12a
2
4
5
3
11a
6
11b
7
8
13a
12b
1
13b
THICK REGION A
THIN REGION B
THICK REGION A

FIG.1

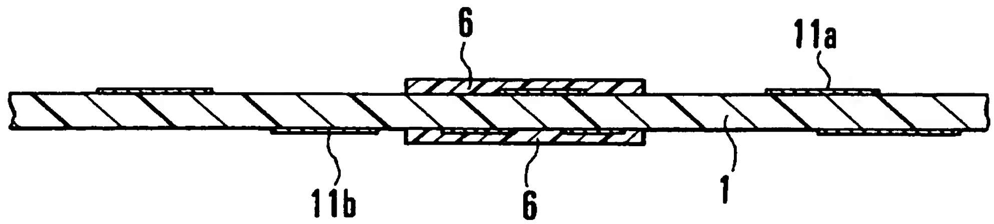

FIG.2A

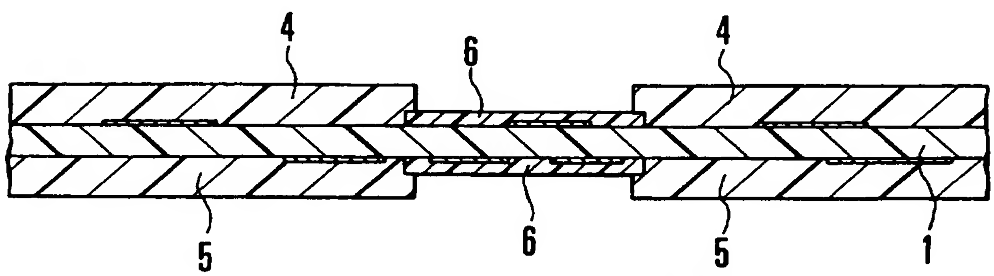

FIG.2B

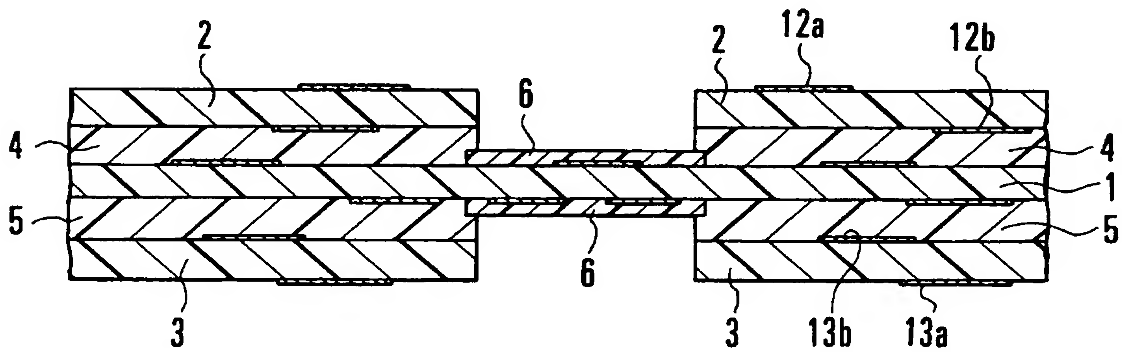

FIG.2C

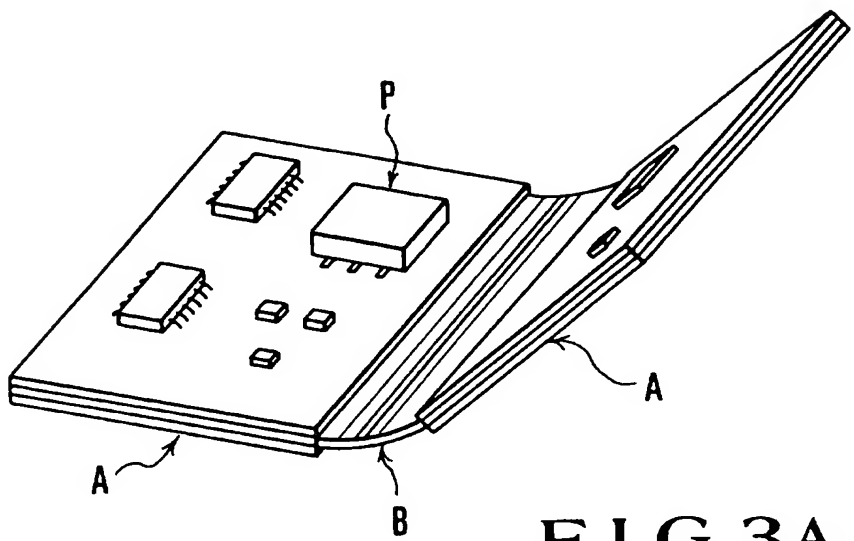

FIG.3A

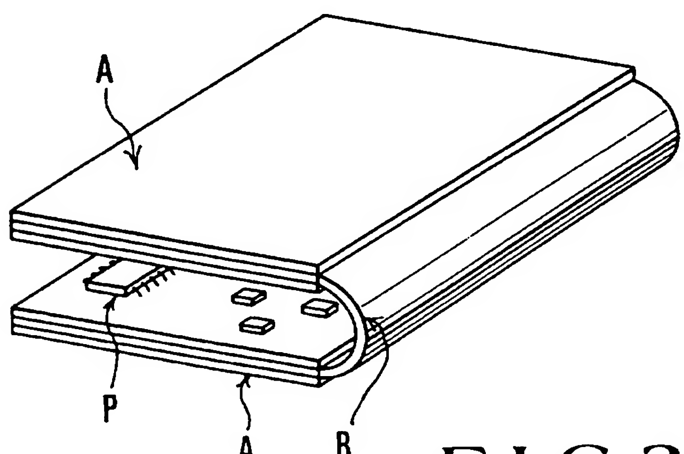

FIG.3B

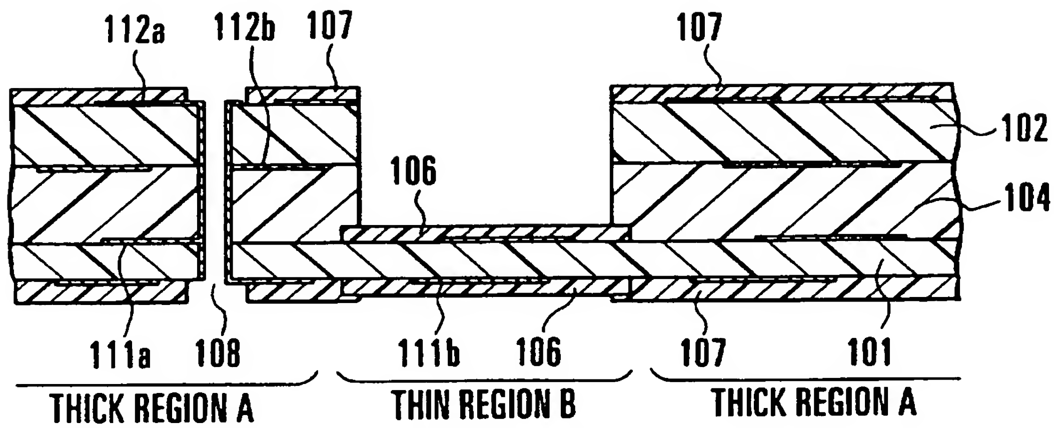

FIG.4

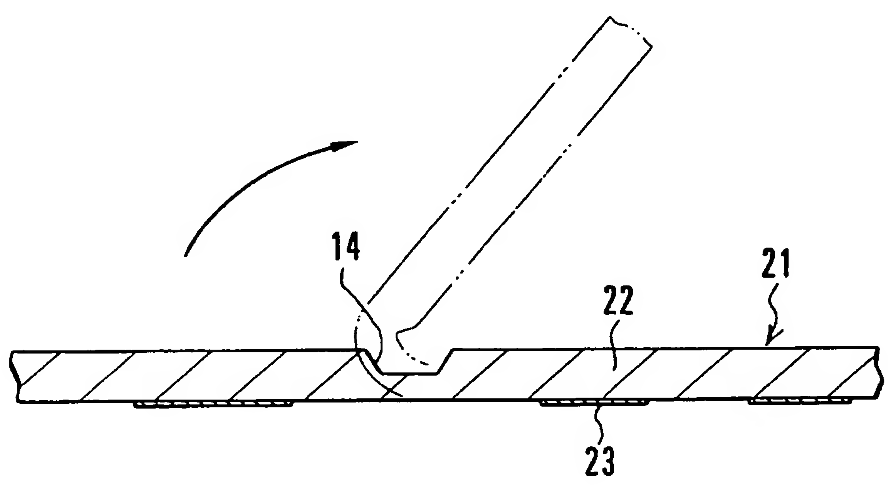

FIG.5
PRIOR ART

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Specification

Title of the Invention

Flexible Multi-Layered Wiring Board and Method of Manufacturing the Same

Background of the Invention

The present invention relates to a multi-layered wiring board and, more particularly, to a flexible multi-layered wiring board bendable in use and a method of manufacturing the same.

A part or all the printed wiring board used for a communication terminal device or any other electronic device has flexibility due to the limitation of a space in the electronic device. This printed wiring board is bent and then incorporated in the electronic device. For this reason, as such a conventional printed wiring board, a printed wiring board obtained by forming a predetermined conductive pattern on a flexible polyimide base has been used. A multi-layered printed wiring board having a large number of layers by using polyimide bases has also been proposed.

If the thickness of a board is increased, however, its flexibility is decreased even with a polyimide base, so that an increase in thickness is limited. For example, when a multi-layered wiring board is constituted by three or more layers, desired

flexibility cannot be obtained. It is difficult to incorporate this board in an electronic device. For this reason, e.g., Japanese Patent Laid-Open No. 4-112594 proposes the following printed wiring board. That is, as shown in Fig. 5, a portion 14 of a printed wiring board 21 constituted by an insulating base 22 and a circuit pattern 23 is irradiated with a laser beam to decrease the thickness of the portion 24 of the insulating base 22. The printed wiring board 21 is bent at the thin portion 14. In this manner, the printed wiring board 21 has flexibility.

In this general multi-layered wiring board using a polyimide base, it is confirmed that problems are posed on the micropatterning accuracy of a circuit pattern formed by printing, and the like due to a polyimide having a high absorption. More specifically, due to the high absorption, bubbles are produced between inner layers by reflow or the like in the assembly of an electronic device on a multi-layered wiring board, the dimensions of the multi-layered wiring board are changed, an insulating resistance is decreased, and the like. The electrical characteristics of the board, therefore, are changed to easily change the impedance of an electronic circuit, and particularly an RF circuit, formed on the board, and easily lose the gain.

To the contrary, if a glass epoxy base is used, there is provided a printed circuit board which

can hardly be influenced by a deterioration over time and an environmental change and has stable electrical characteristics. However, the flexibility of this glass epoxy base is lower than that of an epoxy base. For this reason, e.g., Japanese Utility Model Laid-Open No. 62-80369 tries to assure the flexibility of a printed wiring board by forming the board so as to limit a thickness within the range of 0.05 to 0.25 mm.

Also in the glass epoxy base, however, if the entire thickness is decreased as described above, degradations in electrical characteristics such as an inter-signal interference, a change in impedance, and a loss of the gain may undesirably occur in constituting, e.g., an RF microstrip line. When a multi-layered wiring board having two or more layers is practically formed using glass epoxy bases, the entire thickness of the glass epoxy bases becomes larger than that shown in Japanese Utility Model Laid-Open No. 62-80369, thereby degrading the flexibility.

To allow such a multi-layered wiring board consisting of a glass epoxy base to have flexibility, it is considered that part of the board is irradiated with a laser beam to decrease a thickness, as in Japanese Patent Laid-Open No. 4-112594. In practice, it is difficult to decrease the thickness of a glass epoxy base by this method, so this method cannot be used without any change. In addition, if the thickness is

decreased by such a method, a predetermined circuit pattern formed at this portion is damaged. The circuit pattern at this portion is disconnected to degrade the function of the multi-layered wiring board.

Summary of the Invention

It is an object of at least the preferred embodiments of the present invention to provide a flexible multi-layered wiring board intended to assure flexibility and prevent a degradation in electrical characteristics, and a method of manufacturing the same.

In order to achieve the above object, according to the present invention, there is provided a flexible multi-layered wiring board comprising a first glass epoxy base having a predetermined thickness enough to impart flexibility and circuit patterns formed on two surfaces thereof, part of the first glass epoxy base constituting a thin region, and a remaining portion constituting a thick region, at least one second glass epoxy base having circuit patterns formed on two surfaces thereof and stacked on the first glass epoxy base in the thick region, and a glass epoxy resin layer, arranged between the first and second glass epoxy bases, for insulating the circuit patterns, and adhering the first and second glass epoxy bases to constitute an integrally stacked structure in which the thin region is flexible in a direction of thickness.

Brief Description of the Drawings

Fig. 1 is a sectional view showing a multi-layered wiring board according to an embodiment of the present invention;

Figs. 2A to 2C are sectional views sequentially showing the steps of a method of manufacturing the multi-layered wiring board in Fig. 1;

Figs. 3A and 3B are perspective views showing states of the multi-layered wiring board in Fig. 1 before and after bending, respectively;

Fig. 4 is a sectional view showing a modification of the multi-layered wiring board of the present invention; and

Fig. 5 is a sectional view showing a conventional flexible printed wiring board.

Description of the Preferred Embodiment

An embodiment of the present invention will be described below with reference to the accompanying drawings. Fig. 1 shows the main portion of a multi-layered wiring board according to an embodiment of the present invention. Fig. 1 exemplifies the multi-layered wiring board obtained by stacking three insulating bases 3, 1, and 2 in this order so as to sandwich the insulating base 1 between the insulating bases 2 and 3. This multi-layered wiring board has a total of six-layered circuit patterns formed on the upper and lower surfaces of the insulating bases 1, 2,

and 3, respectively. Each of the three insulating bases 1, 2, and 3 consists of a glass epoxy base called a prepreg. Of these glass epoxy bases, the middle glass epoxy base 1 is formed to have a thickness of 50 to 100 µm so as to stand bending. Each of the upper and lower glass epoxy bases 2 and 3 is formed to have an arbitrary thickness of 100 µm or more.

Predetermined circuit patterns 11a, 11b, 12a, 12b, 13a, and 13b each consisting of a copper foil are formed on the upper and lower surfaces of the insulating bases 1, 2, and 3, respectively. These glass epoxy bases 1, 2, and 3 are stacked through glass epoxy resin layers 4 and 5 in regions (thick regions A) except for part of the glass epoxy base 1 to be sandwiched. The glass epoxy bases 1, 2, and 3 are strongly adhered to each other through the glass epoxy resin layers 4 and 5 to form an integral structure. Protection films 6 such as polyimide films are formed on the upper and lower surfaces of the glass epoxy base 1 in the region (thin region B) where no base is stacked, covering the circuit patterns 11a and 11b.

Insulating protection films (solder resist films) 7 consisting of a material such as ultraviolet-curing ink are formed on exposing surfaces, i.e., the two upper surfaces of the glass epoxy bases 1 and 2, and the lower surface of the glass epoxy base 3 are covered to cover the circuits patterns on these

surfaces. Through holes 8 extending through the glass epoxy bases 1, 2, and 3 in the direction of thickness are formed to electrically connect the six-layered circuit patterns.

Figs. 2A to 2C sequentially show the steps of a method of manufacturing the multi-layered wiring board in Fig. 1. First of all, as shown in Fig. 2A, the glass epoxy base 1 to be sandwiched is formed to have a thickness of 50 to 100 μm so as to stand bending. Copper foils formed on the two surfaces of the glass epoxy base 1 are selectively etched by photolithography to form the circuit patterns 11a and 11b. Thin polyimide films are adhered as the protection films 6 to the two surfaces of the glass epoxy base 1 in a region to be bent.

Next, as shown in Fig. 2B, the glass epoxy resin layers 4 and 5 are formed by selective printing or the like to the upper and lower surfaces of the glass epoxy base 1 in regions except for the region where the polyimide films 6 are adhered to have a thickness of about 100 to 200 μm. In this case, thin glass epoxy resin plates each having a predetermined size and thickness may be arranged on and adhered to the two surfaces of the glass epoxy base 1.

As shown in Fig. 2C, the circuit patterns 12a, 12b, 13a, and 13b are respectively formed on the upper and lower surfaces of the glass epoxy bases 2 and 3 each

having a thickness of 100 μm or more by using copper foils according to the above method. These glass epoxy bases 2 and 3 are adhered to the glass epoxy resin layers 4 and 5 respectively formed to the upper and lower surfaces of the glass epoxy base 1, respectively. The three glass epoxy bases 1, 2, and 3 are vertically pressed by a press machine. The glass epoxy resin layers are hardened to form a multi-layered wiring board having a total thickness of about 1 mm.

Thereafter, through holes are formed in required portions. The through holes 8 for electrically connecting the circuit patterns to each other are formed by, e.g., metallizing a region including the through holes to form the multi-layered wiring board shown in Fig. 1.

As a result, the multi-layered wiring board formed in this manner has the thin region B constituted by only one glass epoxy base 1, and the thick regions A obtained by stacking the three glass epoxy bases 1, 2, and 3. The sufficiently thick board, therefore, can be assured. A circuit such as an RF microstrip line is formed in the thick region A having the multi-layered structure to prevent degradations in electrical characteristics such as an inter-signal interference, a decrease in impedance, and a loss of the gain. On the other hand, the flexibility of the multi-layered wiring board can be assured in the thin region B due to the

presence of the thin region B in part of this multi-layered wiring board. Fig. 3A shows a state in which various electronic components P are mounted in the regions having the multi-layered wiring structures as the thick regions A, and then the multi-layered wiring board is bent at the thin region B. As shown in Fig. 3B, the multi-layered wiring board can be bent through substantially 180° so as to allow the two thick regions A, which sandwich the thin region B therebetween and have the multi-layered structures, to face each other.

In this manner, the thin region B for flexibility is provided as part of the multi-layered wiring board having the thick regions A. Since the thickness of the thin region B is decreased not by, e.g., being irradiated with a laser beam, the circuit pattern is not damaged and disconnected in this thin region B, and the function of the multi-layered wiring board is not degraded. Especially by forming the protection films 6 on the thin region B, one of the circuit patterns 11a and 11b which is exposed on the outer surface of the multi-layered wiring board bent at a bending portion can be effectively prevented from being damaged.

The above embodiment has exemplified the structure in which the thin region B is formed by the second glass epoxy base 1 in the three-layered structure

constituted by the glass epoxy bases 1, 2, and 3, thereby assuring the flexibility. Alternatively, the glass epoxy base 1 which has the thin region B may be arranged on the first or third layer.

In addition, the above embodiment has exemplified the three-layered wiring board. The number of layers is not limited to three. The multi-layered wiring board may be constituted as follows. That is, as shown in Fig. 4, two glass epoxy bases 101 and 102 are stacked through a glass epoxy resin layer 104 to form the thick regions A, and only one of the glass epoxy bases 101 and 102 forms the thin region B to assure flexibility. Four-layered circuit patterns 111a, 111b, 112a, and 112b are formed on the glass epoxy bases 101 and 102, respectively. Reference numeral 106 denote protection films; 107, insulating protection films; and 108, a through hole.

Further, the multi-layered wiring board may be constituted by four or more glass epoxy bases, and a thin region may be formed by one of the glass epoxy bases.

As has been described above, according to the present invention, the thin region constituted by only one glass epoxy base is formed as part of the plane region of the multi-layered wiring board obtained by stacking a plurality of glass epoxy bases each of which has the circuit patterns respectively formed on the

upper and lower surfaces thereof. With this arrangement, the electrical characteristics can be effectively improved by using the glass epoxy bases. In addition, the flexibility of the multi-layered wiring board can be assured in the thin region, and the multi-layered structures can be realized in the other regions. Therefore, the flexible multi-layered wiring board can be realized with the advantage of the multi-layered structure.

The insulating protection films such as polyimide films are formed on the surfaces of one glass epoxy base which constitutes the thin region. This insulating protection films can protect the circuit patterns formed on this glass epoxy base from bending.

According to the method of manufacturing the multi-layered wiring board of the present invention, insulating protection films are formed on the upper and lower surfaces in part of the flat region of the first glass epoxy base which has circuit patterns formed thereon and is formed to have a thickness enough to impart flexibility. A glass epoxy resin layer is formed on at least one of the upper and lower surfaces of the glass epoxy base except for this region. Another relatively thick glass epoxy base having circuit patterns formed thereon is placed on the glass epoxy resin layer. These layers are pressed against the first glass epoxy base to form an integral structure. In this

manner, a flexible multi-layered wiring board can be manufactured in a small number of steps.

Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently of other disclosed and/or illustrated features.

The appended abstract as filed herewith is included in the specification by reference.

What is claimed is:

1. A flexible multi-layered wiring board characterized by comprising:

a first glass epoxy base (1, 101) having a predetermined thickness enough to impart flexibility and circuit patterns (11a, 11b, 111a, 111b) formed on two surfaces thereof, part of said first glass epoxy base constituting a thin region (B), and a remaining portion constituting a thick region (A);

at least one second glass epoxy base (2, 102) having circuit patterns (12a, 12b, 112a, 112b) formed on two surfaces thereof and stacked on said first glass epoxy base in said thick region; and

a glass epoxy resin layer (4, 104), arranged between said first and second glass epoxy bases, for insulating said circuit patterns, and adhering said first and second glass epoxy bases to constitute an integrally stacked structure in which said thin region is flexible in the direction of its thickness.

2. A board according to claim 1, wherein said first glass epoxy base has a thickness of 20 to 100 μm.

3. A board according to claim 1, further comprising protection films (6, 106) for covering said two surfaces of said first glass epoxy base in said thin region to protect said circuit patterns.

4. A board according to claim 3, wherein said protection films comprise polyimide films adhered to said two surfaces of said first glass epoxy base in said thin region.

5. A board according to claim 1, further comprising insulating protection films (7, 107) for covering exposing surfaces of said stacked structure corresponding to said thick region to insulate and protect said circuit patterns.

6. A board according to claim 1, wherein said second glass epoxy base has a thickness larger than a thickness of said first glass epoxy base.

7. A flexible multi-layered wiring board characterized by comprising:

a first glass epoxy base (1, 101) having a predetermined thickness enough to impart flexibility and circuit patterns (11a, 11b, 111a, 111b) formed on two surfaces, part of said first glass epoxy base constituting a thin region (B), and a remaining portion constituting a thick region (A);

second and third glass epoxy bases (2, 3, 102) which have circuit patterns (12a, 12b, 13a, 13b, 112a, 112b) formed on two surfaces of each of said second and third epoxy bases, are respectively stacked on said two

surfaces of said first glass epoxy base in said thick region, and have a thickness larger than a thickness of said first glass epoxy base;

glass epoxy resin layers (4, 5, 104), respectively arranged between said first glass epoxy base and said second and third glass epoxy bases, for insulating said circuit patterns, and respectively adhering said first glass epoxy base and said second and third glass epoxy bases to constitute an integrally stacked structure in which said thin region is flexible in a direction of thickness;

protection films (6, 106) for covering said two surfaces of said first glass epoxy base in said thin region to protect said circuit patterns; and

insulating protection films (7, 107) for covering exposing surfaces of said stacked structure corresponding to said thick region to insulate and protect said circuit patterns.

8. A method of manufacturing a flexible multi-layered wiring board, characterized by comprising:

the step of forming insulating protection films (6, 106) on two surfaces, in a predetermined region (B), of a first glass epoxy base (1, 101) having a predetermined thickness enough to impart flexibility and circuit patterns (11a, 11b, 111a, 111b) formed on said two surfaces;

the step of forming a glass epoxy resin layer (4, 104) on at least one surface of said first glass epoxy base in a region (A) where said insulating protection film is not formed;

the step of stacking, on said glass epoxy resin layer, a second glass epoxy base having circuit patterns (12a, 12b, 112a, 112b) formed on two surfaces thereof; and

the integrally stacked structure constituting step of pressing at least said first and second glass epoxy bases and said first glass epoxy resin layer to constitute an integrally stacked structure.

9. A method according to claim 8, further comprising the steps of:

forming a second glass epoxy resin layer (5) on the other surface of said first glass epoxy base in said region where said insulating protection film is not formed in correspondence with said first glass epoxy resin layer; and

stacking, on said second glass epoxy resin layer, a third glass epoxy base (3) having circuit patterns (13a, 13b) formed on two surfaces thereof, and

wherein the integrally stacked structure constituting step constitutes an integrally stacked structure obtained by pressing said first to third glass

epoxy bases and said first and second glass epoxy resin layers.

10. A method according to claim 8, further comprising the step of forming an insulating protection film (7, 107) on an exposing surface of said stacked structure corresponding to a thick region to insulate and protect said circuit pattern.

11. A flexible multi-layered wiring board, or a method of manufacture thereof substantially as herein described with reference to Figures 1 to 4 of the accompanying drawings.

Patents Act 1977 **Examiner's report to the Comptroller under Section 17** **(The Search report)**	Application number GB 9521224.7
Relevant Technical Fields (i) UK Cl (Ed.N) H1R(RAC, RAD, RAH) (ii) Int Cl (Ed.6) H05K 1/00, 1/02, 3/00, 3/46	Search Examiner J DONALDSON Date of completion of Search 7 NOVEMBER 1995
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE: WPI	Documents considered relevant following a search in respect of Claims :- 1 TO 11

Categories of documents

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P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2279180 A	(NEC) See page 6 line 6 to page 7 line 20	1, 2, 6
X	EP 0493939 A1	(COMPAQ) See column 8, line 56 to column 11, line 22.	1-10

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